DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE FOR OPERATIONAL HEALTH (AFMC)
BROOKS CITY-BASE TEXAS

29 June 2007

MEMORANDUM FOR ACC AMIC
COMMUNICATIONS-ELECTRONICS
SYSTEMS DIVISION
ATTN: TSGT RICKEY PRIMES
11817 CANON BLVD SUITE 306
NEWPORT NEWS VA 23606

FROM: AFIOH/SDR
2350 Gillingham Drive
Brooks City-Base TX 78253-5103

SUBJECT: Consultative Letter, IOH-SD-BR-CL-2007-0073, Radio Frequency Radiation Hazard Survey for Hemispheric Radar Systems in the Republic of Colombia

1. Introduction:

MSgt Mark Randall from ACC Program Management Squadron at Langley AFB, VA requested radio frequency radiation (RFR) surveys for two Hemispheric Radar Systems (HRS) employing AN/TPS-70 radars units. Capt Krystyn Clark and SSgt Cesar Valverde from the Air Force Institute for Operational Health (AFIOH), Radiation Surveillance Division (SDR), Health Physics Consulting Branch (SDRH) traveled to The Republic of Colombia to perform RFR surveys from 8-14 Feb 07. The purpose was to survey two of the five radar systems prior to the USAF turning these radar systems over to the Colombian government. A secondary request was made to perform an x-ray survey to ensure no hazardous levels of ionizing radiation were generated from the radar transmitter or transmission lines. AFIOH personnel completed surveys at San Jose del Guaviare and San Andres Island. There are no hazards to personnel from RFR or x-ray emissions generated by the radar systems that were evaluated. Administrative data is shown in Attachment 1.

2. Background:

a. The AN/TPS-70 Ground Theater Air Control Systems radar is typically used as a ground-based portable system but can also be permanently mounted inside a radome for long-term use. The HRS radars surveyed were permanently mounted and used for counter drug tracking surveillance operations. The AN/TPS-70 was surveyed at the same time that the Identification Friend or Foe (IFF) radar system was employed. There are five AN/TPS-70 radar systems located throughout Colombia in Marandua, Riohacha, San

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Andres, San Jose and Tres Esquinas. Once the turnover is complete, the AN/TPS-70 radar systems will be operated by the Colombian Air Force (Fuerza Aerea de Colombia, FAC) instead of current US government contractors. Transfer of all five systems located in Colombia is expected prior to FY08. Although these radar systems typically scan 360 degrees, they were placed in a fixed direction for this survey for optimal data collection and safety.

b. The current Air Force Occupational Safety and Health (AFOSH) Standard, 48-9, *'Radio Frequency Radiation (RFR) Safety Program,'* 1 August 1997, establishes maximum permissible exposure limits (PELs) for controlled and uncontrolled environments. The personnel theoretical far-field hazard distance is where the power density equals the PEL. Measurement locations with associated power density levels and general findings are listed in the following sections.

3. Findings:

a. Both AN/TPS-70 radar systems were used in conjunction with an IFF radar system. The main focus for the survey was the more accessible beam from the AN/TPS-70 radar system. The AN/TPS-70 and IFF systems were measured simultaneously to fully assess any potential hazardous power density levels to personnel. Refer to Attachment 2 for theoretical hazard distance calculations and PELs for this radar system.

b. The first survey was conducted at the San Jose site on 10 Feb 07. Based on the parameters provided by the site (Attachment 3), the controlled PEL is 10 mW/cm^2 and the uncontrolled PEL is 2 mW/cm^2. All RFR measurements were indistinguishable from background measurements of 0 mW/cm^2 in the control room areas, ground areas below the radome, steps leading to the radome and platform below the radome. Measurements were taken from the catwalk outside the radome before proceeding inside the radome. The only location above background outside the radome was directly in front of the antenna about 8 ft above the platform floor. A maximum measurement of 1.1 mW/cm^2, which is well below the 10 mW/cm^2 PEL, was recorded at this location.

Power density measurements were also taken inside the radome. All of the survey measurements were below the controlled PEL except for a location directly in front of the radar at a height above 7 feet. Power densities at this location exeeded 97 mW/cm^2. Attachment 3 provides a summary of the survey results. The accompanying personnel from ACC advised AFIOH/SDRH that personnel do not work inside the radome during radar operation. Interlocks are present to prevent this scenario and had to be overridden to perform the RFR survey. A ground survey was performed along the perimeter of the elevated patrol locations during normal radar operation due to frequent FAC personnel occupancy. All measurements were indistinguishable from background. In summary, there is no RFR hazard under normal working and operating conditions from the AN/TPS-70 radar system.

Measurements were also taken for x-ray emissions in the emitter and control room areas for ionizing radiation. A maximum exposure rate of 78 microRoentgen/hr (µR/hr) was

measured inside the emitter housing for x-rays emissions. This dose is well below any international public dose limits and does not require any posting nor additional requirements. Occupied areas in the control room were indistinguishable from the background exposure rate of 4 µR/hr.

c. The second survey was conducted at the San Andres site on 12 Feb 07. Based on the parameters provided by the site (Attachment 4), the controlled PEL is 10 W/cm^2 and the uncontrolled PEL is 2 W/cm^2. This location was similar to the San Jose survey with the main differences being that the San Andres radome is smaller (27 ft diameter instead of the 32 ft diameter of the San Jose radome), and the antenna is closer to the catwalk inside the radome. All RFR measurements were indistinguishable from background in the control room areas, ground areas below the radome, and ladder leading to the radome. No measurements were made outside the radome because there is no exterior catwalk at this location.

Power density measurements were taken inside the radome. All of the survey measurements were below the controlled PEL except for a location 8.5 feet above the platform, at the maximum linear distance from the face of the antenna. At this location, the power density was 90 mW/cm^2. A person performing maintenance at this location will be exposed to a power density above the controlled PEL. However, interlocks and administrative controls are in place to prevent routine maintenance inside the radome while the antenna is on. Attachment 4 provides a summary of the survey results.

Measurements were also taken for x-ray emissions in the emitter and control room areas for ionizing radiation. The emitter housing had a maximum measurement of 79 µR/hr background levels of x-ray emissions. There was one area discovered outside the emitter housing that had a maximum measurement of 1.5 mR/hr on contact with the housing (Attachment 4). Although this measurement was above background, it is an outdoor location that is not normally occupied by personnel at the site. The area should be considered unrestricted because there is no hazard to personnel for routine operations or passing through the area. Routine operations would be considered activities in the vicinity of the emitter housing such as lawn maintenance or painting the exterior surface. A possible explanation for these x-ray emissions was explained by the contractor that some lead may have been scraped from the waveguide during one of the maintenance operations.

4. Recommendations:

a. Under normal operating procedures, there are no hazardous levels of RFR to personnel working at either the San Andres or San Jose sites. Personnel should continue use of interlocks and administrative controls in order to prevent work inside the radome during operation.

b. There is no ionizing radiation hazard to personnel working at either site due to the AN/TPS-70 radar system. No additional controls or restrictions are needed.

5. If you have questions concerning this report or follow-up survey measurements, please contact Capt Krystyn Clark at DSN 240-4297 or krystyn.clark@brooks.af.mil, or the ESOH Service Center at 1-888-232-ESOH. In order to improve our services, please complete and return the attached critique (Attachment 5).

//signed//

SCOTT M. NICHELSON, Lt Col, USAF, BSC, CHP, CIH
Chief, Radiation Surveillance Division

Attachments:
1. Administrative Data
2. IFF Theoretical Hazard Distance Calculations
3. San Jose Site Data
4. San Andres Site Data
5. X-rays from the Emitter Housing at San Andres
6. Critique

Attachment 1
Administrative Data

1. Personnel Contacted

MSgt Mark Randall, Function Manager Ground Radar Systems, Langley AFB, VA
Charlie DuPont, HQ/ACC/A6OD Technical Support Team
Dennis Brinson, Site Program Manager at San Jose
Greg Bailey, Site Program Manager at San Andres

2. Equipment Used

Narda Meter 8715, S/N 20013, Calibrated 02/06
Narda Probe 8723D, S/N 18006, Calibrated 02/06
Victoreen 451P-RYR Model Number 05687, S/N 0-0212, Calibrated 12/06

3. Emitters Surveyed

AN/TPS-70(v)5 Radar
2900-3100 MHz (S-band)
Peak power 2.8 megawatts
Pulse width 6.8 +/- 0.15 µsec
Pulse repetition frequency 235 Hz fixed and 250 Hz staggered
Azimuth 1.6 ± 0.2 degrees
Elevation 2.4 ± 0.2 degrees
Antenna Gain 35 dB

IFF System
1030 MHz
Antenna Type: Linear Dipole array with Sum and Difference Patterns
Peak power 2.0 kilowatts
Pulse repetition frequency 275
Sum Azimuth Beamwidth @ 3 dB points: less than 7.2 degrees
Sum Elevation Beamwidth @ 3 dB points: 0 to at least 50 degrees
Antenna Gain 19 dB minimum

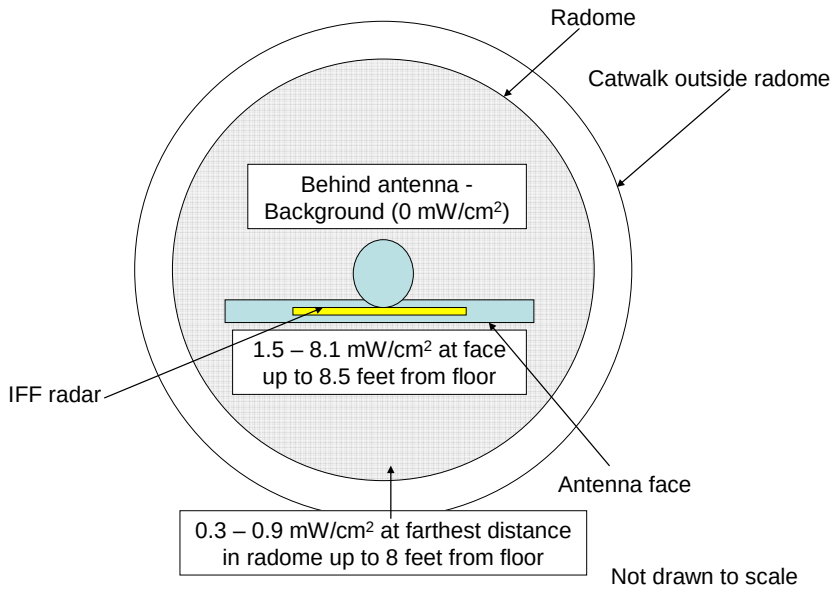
Attachment 2
IFF Theoretical Hazard Distance Calculations

Parameters – not surveyed separately		
Emitter description	IFF	
Frequency	1030	MHz
Peak power	2.0	kW
Pulse width	8.00E-07	sec
PRF	275	hertz
Average power	4.40E-01	Watts
Gain	19	decibels
Absolute gain	79.43	
Beam width - vertical	50	deg
Beam width - horizontal	7.2	deg
Scan angle	360	deg
Controlled PEL	3.43	mW/cm^2
Uncontrolled PEL	0.69	mW/cm^2
VERTICAL		
Distance to PEL controlled	0.11	meters
Distance to PEL controlled	0.35	feet
Distance to PEL uncontrolled	0.24	meters
Distance to PEL uncontrolled	0.78	feet
HORIZONTAL		
Distance to PEL controlled	0.04	meters
Distance to PEL controlled	0.13	feet
Distance to PEL uncontrolled	0.09	meters
Distance to PEL uncontrolled	0.30	feet

Attachment 3
San Jose Site Data

San Jose AN/TPS-70 Radome

San Jose Radar Diagram



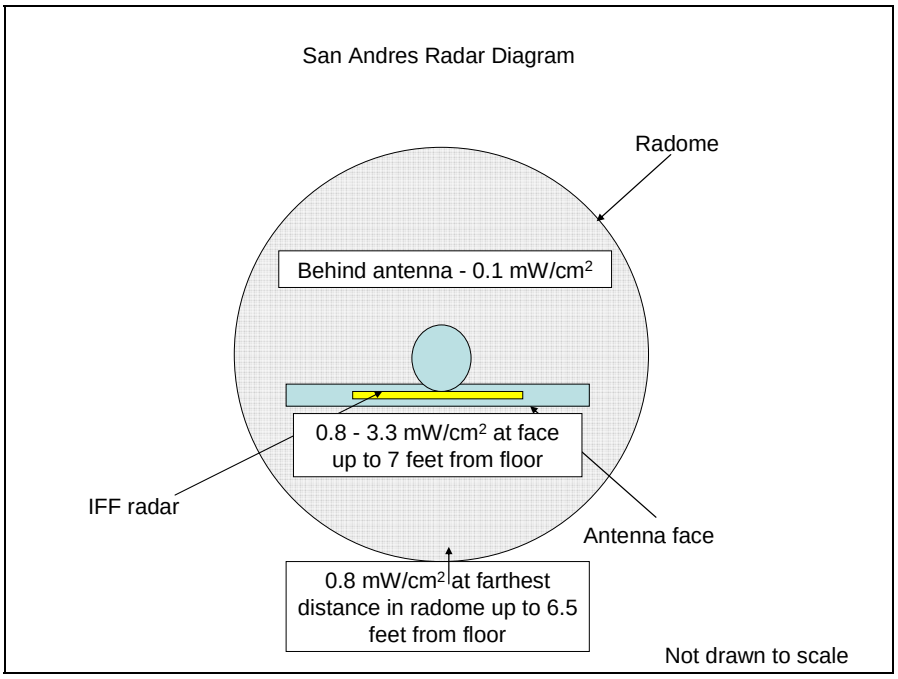
Survey results

Survey Location	Power Density (mW/cm^2)
Background	0.0
Transmission lines and emitter housing	0.0
Ground accessible areas	0.0
Base of tower	0.0
Stairs leading to tower	0.0
Outside catwalk around radome	0.0
Behind and sides of antenna up to ~8 ft	0.0
Inside radome behind antenna	0.0
In front of antenna at face ~ 7 ft high	1.5
In front of antenna at face ~ 8.5 ft high	8.1
In front of antenna at max distance within sphere	0.6
In front of antenna at max distance within sphere ~7 ft high	0.9

Parameters as surveyed

Emitter description	AN/TPS-70(v)5	
Emitter location	San Jose	
Frequency	2987.36	MHz
Peak power	2800	kW
Pulse width	6.80E-06	sec
PRF	275.00	hertz
Average power	5236.00	Watts
Gain	34.50	decibels
Absolute gain	2818.38	
Beam width - vertical	2.40	deg
Beam width - horizontal	1.60	deg
Scan angle	360.00	deg
Controlled PEL	9.96	mW/cm^2
Uncontrolled PEL	1.99	mW/cm^2
VERTICAL		
Distance to PEL controlled	8.87	meters
Distance to PEL controlled	29.08	feet
Distance to PEL uncontrolled	19.83	meters
Distance to PEL uncontrolled	65.03	feet
HORIZONTAL		
Distance to PEL controlled	7.24	meters
Distance to PEL controlled	23.75	feet
Distance to PEL uncontrolled	16.19	meters
Distance to PEL uncontrolled	53.10	feet

Attachment 4
San Andres Site Data



San Andres AN/TPS-70 Radome

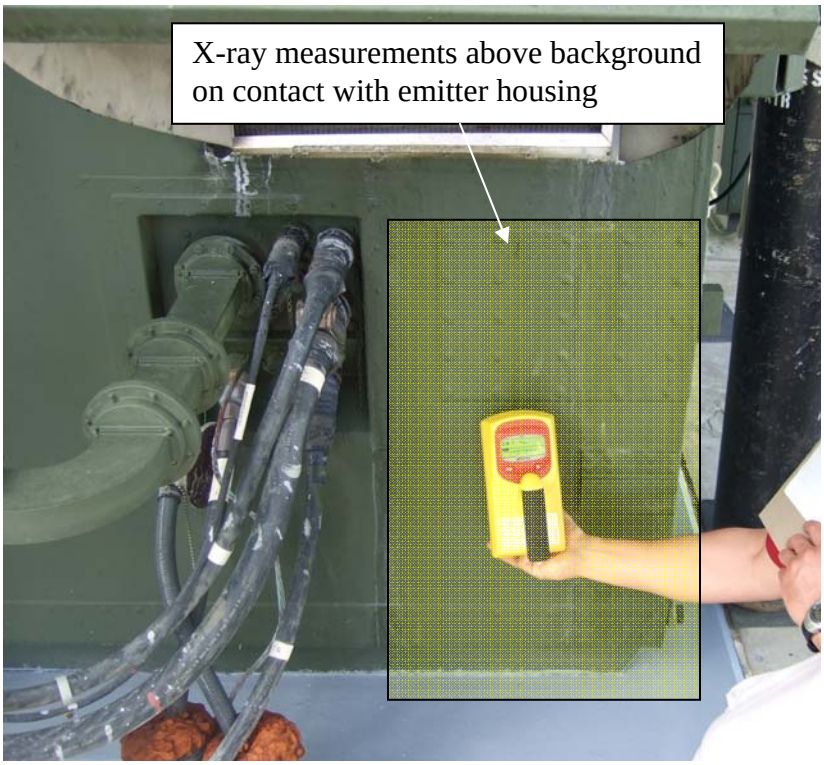
Survey results

Survey Location	Power Density (mW/cm^2)
Background	0.0
Transmission lines and emitter housing	0.0
Ground accessible areas	0.0
Base of tower	0.0
Ladder leading to tower	0.0
Behind antenna	0.1
In front of antenna at face ~ 7 ft high	3.3
In front of antenna at max distance within sphere ~ 6.5 ft high	0.8
In front of antenna at max distance within sphere ~8.5 ft high	89.7

Parameters as surveyed

Emitter description	AN/TPS-70(v)5	
Emitter location	San Andres	
Frequency	3029.12	MHz
Peak power	2800	kW
Pulse width	6.80E-06	sec
PRF	275.00	hertz
Average power	19.69	Watts
Gain	34.50	decibels
Absolute gain	2818.38	
Beam width - vertical	2.40	deg
Beam width - horizontal	1.60	deg
Scan angle	360.00	deg
Controlled PEL	10.00	mW/cm^2
Uncontrolled PEL	2.02	mW/cm^2
VERTICAL		
Distance to PEL controlled	8.85	meters
Distance to PEL controlled	29.02	feet
Distance to PEL uncontrolled	19.69	meters
Distance to PEL uncontrolled	64.58	feet
HORIZONTAL		
Distance to PEL controlled	7.22	meters
Distance to PEL controlled	23.70	feet
Distance to PEL uncontrolled	16.08	meters
Distance to PEL uncontrolled	52.73	feet

Attachment 5
X-rays from the emitter housing at San Andres



Attachment 6

POINT OF CONTACT:	**Capt Krystyn Clark**	**BASE NAME:**	**Brooks City-Base**
POC PHONE:	**DSN 240-4297**	**DIVISION:**	**AFIOH/SDRH**
STINFO NUMBERS:	**IOH-SD-BR-CL-2007-0073**		

This survey is used to help us improve our service to you. Your answer will be held in confidence and will significantly impact on how we allocate resources to meet your needs. Please return this completed form promptly.

Grading Scale:

1	**2**	**3**	**4**	**5**	**6**
Extremely Dissatisfied	Dissatisfied	Slightly Dissatisfied	Slightly Satisfied	Satisfied	Extremely Satisfied

A	Timeliness: Did you receive your results within the published time limits?	1	2	3	4	5	6
B	Accuracy: Is the report in the proper format? Are your address and other data correct?	1	2	3	4	5	6
C	Content: Does the report answer your questions and provide the necessary data? Are our services per dollar adequate when compared to civilian sector?	1	2	3	4	5	6
D	Customer Support: Have we been courteous and helpful in meeting your special needs (priority service, reporting, format, etc.)?	1	2	3	4	5	6
E	Consult Service: Have we answered your questions and provided necessary materials or reviewed to support your mission requirements?	1	2	3	4	5	6
F	Overall Rating: How would you rate our overall service to you?	1	2	3	4	5	6

Comments / Suggestions: Are there other services that you would like provided in the future? Are there any specifics of your current service you would like to discuss? (Use additional pages if more space is required)

Please return to:

AFIOH/SDR
Attention: Lt Col Scott M. Nichelson
Chief, Radiation Surveillance Division
2350 Gillingham Drive
Brooks City-Base TX 78235-5103